ISHAM (A.B.)

RECENT CONTRIBUTIONS TO SPHYGMOGRAPHIC SCIENCE

BY

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Recent Contributions to Sphygmographic Science. The most valuable recent contributions to this comparatively new branch of medical science, have been made by Dr. A. T. Keyt. His papers present purely original work, and they are as follows :

1. *The New Sphygmograph.*—Paper read before the American Medical Association, May, 1875 ; abstract in *N. Y. Medical Record*, May 22, 1875 ; published in full in *N. Y. Medical Journal*, January, 1876, and *Cincinnati Clinic*, April 29, 1876.

2. *Cardiographic and Sphygmographic Studies ;* with demonstrations of the Form, Relationship and Chronometry of the Cardiac and Arterial Movements, and interpretations of the graphic curves.—*N. Y. Medical Journal*, July, 1877, and *Cincinnati Clinic*, Aug. 25 and Sept. 1, 1877.

3. *Cardiographic and Sphygmographic Studies ;* demonstrating the time-differences of pulse-wave between different arteries ; duration of the heart-carotid, and presphygmic intervals ; time relations of secondary waves, and the velocity of pulse-wave along different arteries.—*N. Y. Med. Jour.*, Feb'y, 1878 ; *Clinic*, Apr. 13, 1878.

4. *The Human Heart's Revolution, and Relation to it and each other of Ventricular Systole and Diastole.—N. Y. Med. Jour.*, July, 1878 ; *Cin. Lancet and Clinic*, Aug. 31, 1878.

5. The Velocity of the Pulse-Wave and Duration of the Ventricular-Carotid, and Ventricular-Presphygmic intervals in Young Children.—*N. Y. Med. Jour.*, July, 1878 ; *Cin. Lancet and Clinic*, Aug. 31, 1878.

6. *Observations on Bertha Von Hillern's Pulse.—Cin. Clinic*, Apr. 20, 1878.

7. *O'Leary's Pulsations.—Cin. Lancet and Clinic*, July 13, 1878.

8. *The Pulsations of the Fontanel; their Form and Mechanism, and Relations to the Pulsations of the Heart and Arteries and Movements of Respiration.—Cin. Lancet and Clinic*, Sept. 21, 1878.

9. *The Influence of Muscular Exercise upon the Arterial and Cardiac Pulsations.—Cin. Lancet and Clinic*, Nov. 2, 1878.

10. *The Sphygmographic Indications of Heart Disease—Mitral Regurgitation.—Lancet and Clinic*, March 22, 1879.

11. *The Sphygmographic Indications of Heart Disease—Aortic Obstruction.—Lancet and Clinic*, April 19, 1879.

11. *The Influence of the Respiration upon the Form, Rhythm and Succession of the Cardiac and Arterial Pulse-Curves.—Lancet and Clinic*, June 7, 1879.

The instrument used by Dr. Keyt is one invented and perfected by himself. It consists of two uniform sphygmographs and a chronograph arranged and combined in one apparatus, so that one writes its record above the other upon the same smoked glass tablet. The sphygmographs receive the pulsations through the media of elastic membranes, and a column of alcohol above each membrane conveys them to the writing levers. The chronograph runs by clock-work, and writes fifths of seconds. By means of this combined instrument the pulsations at two different points can be simultaneously traced, their characters studied and compared, and their time relations determined. Without further description it may be said that the work of the instrument furnishes ample proof of its efficiency and accuracy. By no other instrument known to the profession could such results have been obtained. Fig. 1 shows exactly the principle of the instrument, although the details of construction, as since improved by the inventor, differ considerably from this representation.

The articles are all illustrated with original actual tracings from which the author formulates his conclusions. The plates, with tracings of superior excellence and appropriate markings, show the results of the various experiments, and exhibit on their face incontestible proofs of the fidelity of the work. A few plates are here reproduced to show the method and style of the illustrations.

The following is a summary of the facts and conclusions announced:

1. In the normal human cardiogram, ventricular systole begins at the lowest point of the main ascending line, and changes

into diastole at the highest point of the main descending line. In very fine cardiograms there are three waves at the top pertaining to systole, and three at the bottom pertaining to diastole. The systolic up-stroke and first wave are interpreted as caused by the commencing contraction of the ventricle and discharge of blood therefrom, and the two subsequent waves by the sustained ventricular contraction under the resistance to the escape of blood as the aorta becomes filled. The diastolic down-stroke is interpreted as produced by the relaxation of the ventricle, the first rise by the refilling of the ventricle, and the two subsequent small waves by auricular contraction and discharge.

2. In the normal arterial trace there are three major waves and three minor ones—the latter, however, very imperfectly shown. They are interpreted as produced, the first by the first blood driven from the ventricle, the second by the last blood driven from the ventricle, and the third, which is a double wave, by the shock and rebound from the closure

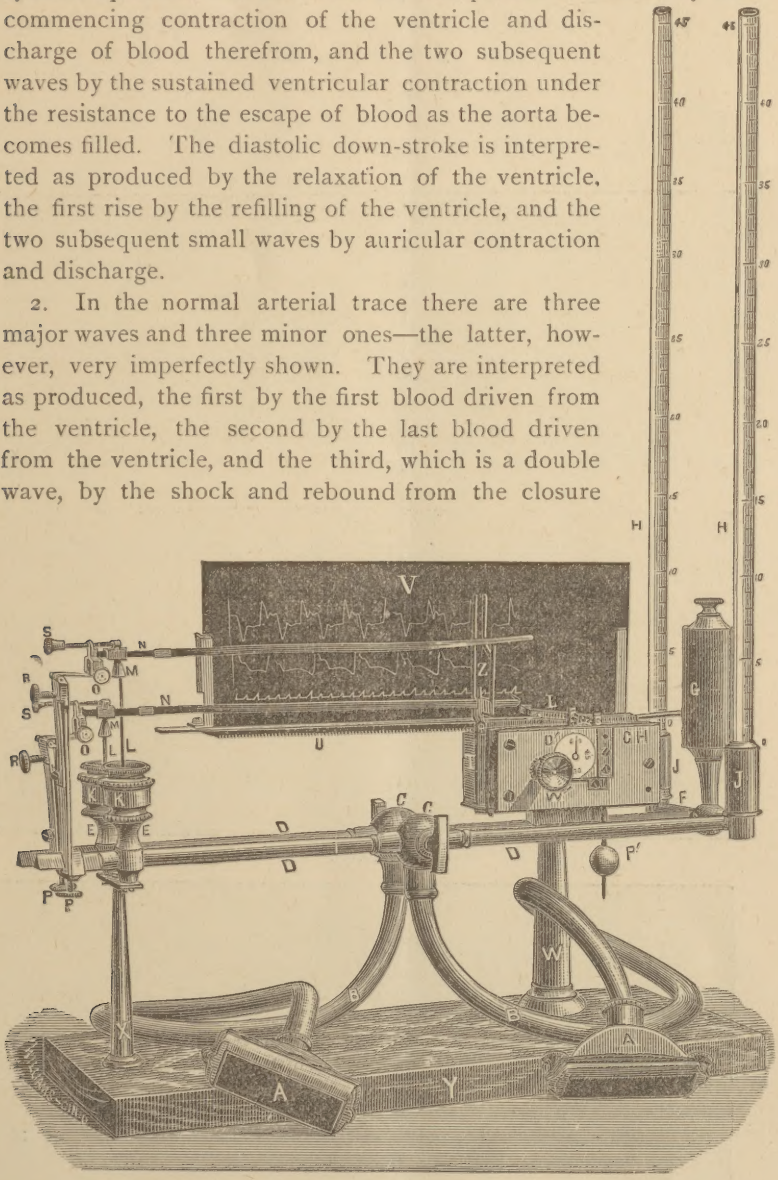

FIG. 1.

of the aortic valves. The minor waves are occasioned successively by auricular contraction, auricular discharge, and the first shock of ventricular contraction, these influences being transmitted to the closed aorta. Thus the first two are ventricular systolic, and the third, or aortic, and the minor waves are ventricular diastolic. The first is as much a fluent, or "tidal" wave, as the second. The term "percussion or shock," as applied to the first pulse-wave, is discarded as conveying an erroneous idea.

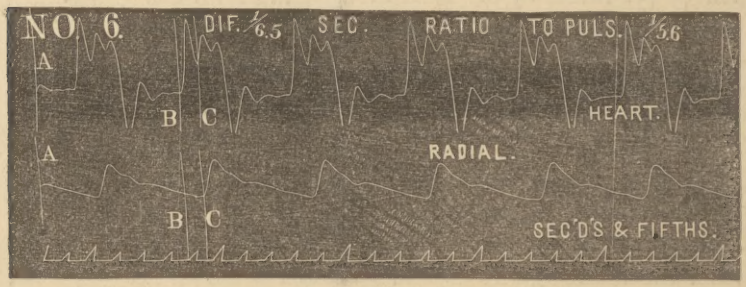

FIG. 2.

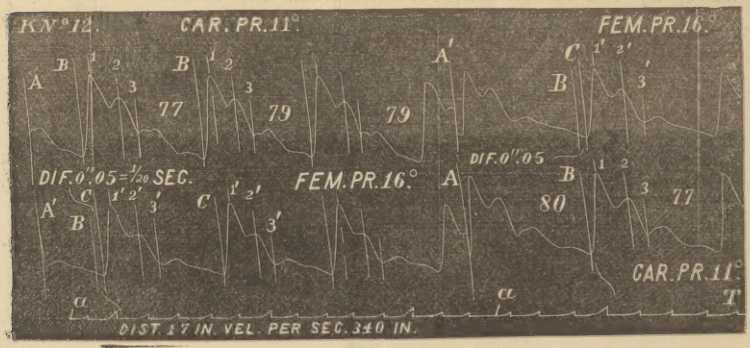

FIG. 3.

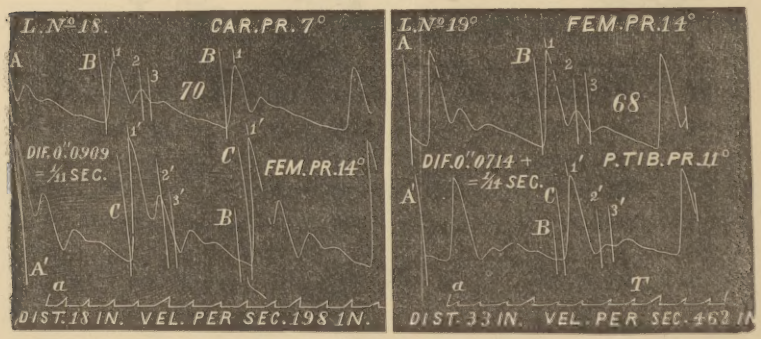

FIG. 4.

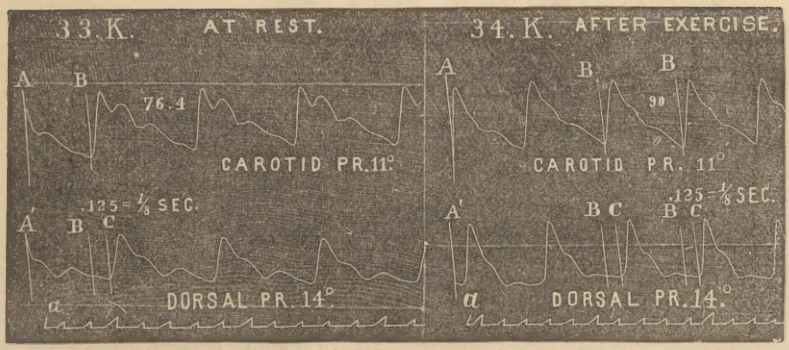

FIG. 5.

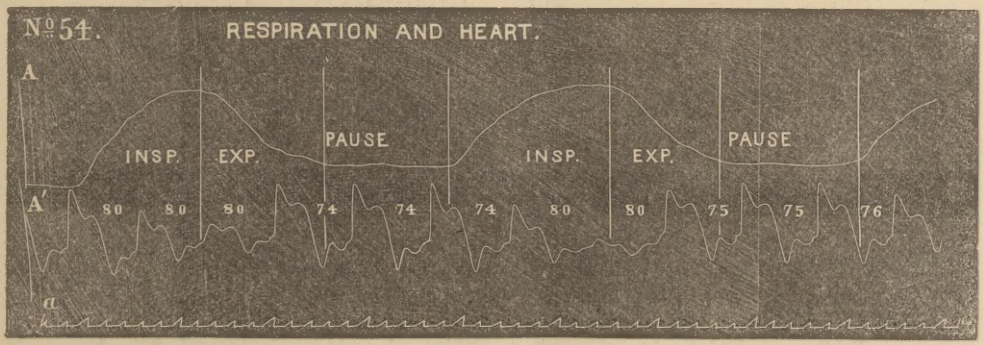

FIG. 6.

Time–differences.

3. The average time-difference between the beginning of the ~~carpulto dise~~ and the beginning of the dorsalis pedis pulse is .1458 second.

4. The average carotid-femoral time-difference, .0704 second.

5. The average femoral-dorsalis pedis time-difference, .0732 second.

6. The average carotid-radial time-difference, .0797 second.

7. The average radial-dorsalis pedis time-difference, .058 second.

8. The average femoral-radial time-difference, little or none.

9. The average ventricular-carotid time-difference, .0884 second, with pulse at 72 per minute.

10. The average ventricular-carotid transit time, .0279 second.

11. The average ventricular presphygmic interval, or time between the beginning of ventricular contraction and that of aortic expansion is .0605 of second, with pulse at 72.

Velocities of the pulse-wave.

12. The mean average velocity of the pulse-wave from the carotid point to the dorsalis-pedis, 361 inches per second.

13. The same from the carotid to femoral is 269 inches per second.

14. The same from the femoral to dorsalis pedis is 464 inches per second.

15. The same from the carotid to radial is 290 inches per second.

Corollaries.

16. The rate of transmission of the pulse-wave along different portions of the arterial tree is not uniform, but considerably diverse.

17. The rate is minimum for the aorta, maximum for the arteries of the lower extremity, and intermediate for those of the upper extremity.

18. Along the same arterial line the rate increases as the distance from the heart increases.

19. In the same healthy individual, in the same arteries, the rate is subject to a limited variation.

20. In different healthy individuals, in the same arteries, the rate is subject to marked diversity, of which the widest is in the aorta.

21. Both in the same and different healthy individuals, the presphygmic portion of the systole of the ventricle is liable to considerable variation.

Time-Relations of the Secondary Waves.

22. The interval between the beginning of the pulse and its acme of expansion is the same in all parts of the arterial system.

23. In certain conditions of the vessels and circulation the second wave keeps close time with the first in the onward flight, while in certain other conditions of the same the second falls notably behind the first in the progress from the heart.

24. The aortic wave rises later in the distal than in the proximal pulses, and latest in the pulse most distant from the heart.

as respects the beginning of the pulse

Phenomena in Young Children.

25. The mean velocity of the pulse wave in the arterial tree is much slower in young children than in adults.

26. In such comparison the greatest diversity is in the lower extremities, where the velocity of the pulse-wave in young children does not exceed one-half that in adults.

27. While in adults the velocity of the pulse-wave is much faster in the lower extremities than in the trunk and upper extremities, in young children such difference does not obtain.

28. The mean velocity of the pulse-wave increases with age. (Inference.)

29. The time-difference between the beat of the heart and the carotid pulse is nearly the same in young children as adults.

30. The presphygmic interval is notably less in young children than in adults.

Rhythmic Changes and their Influence.

31. The velocity of the pulse-wave is not appreciably modified by changes of pulse rhythm.

32. The velocity of the pulse-wave normal to the individual is closely preserved under ordinary physiological variations of the circulation.

33. The presphygmic interval changes with changes of rhythm, the period being longer with rare and shorter with frequent pulsations.

34. In the normal heart the rhythm of its movements is continually changing, and the variation pertains to the duration of its entire revolution, and to that of both systole and diastole.

35. The duration of diastole changes in much greater degree than that of systole.

36. A longer systole may go with a shorter pulsation, and a shorter systole with a longer pulsation.

37. Invariably a longer diastole goes with a longer pulsation, and a shorter diastole with a shorter pulsation.

38. In the normal heart, beating at about 75 to the minute, the average ratio of systole to diastole is very nearly as 2 to 3 ; and the average ratio of the cardiac systolic portion of the pulse to the cardiac diastolic is closely as 1 to 2.

39. The cardiac systolic portion of the pulse compared with the cardiac diastolic portion increases with increase of pulse frequency.

The Fontanel.

40. The fontanel pulsates in unison with the heart ; the basal line and amplitude of its trace fall in inspiration and rise in expiration : its pulsation begins as early as that of the temporal artery in front of the auditory meatus.

The Influence of Respiration.

41. The respiration greatly modifies the form of heart traces ; the more perfect cardiograms being traced during the respiratory pause, while very imperfect or illegible ones are traced during the respiratory act.

42. Inspiration depresses the basal line, depresses the amplitude, and accelerates the pulse ; while expiration raises the basal line, raises the amplitude, and slows the pulse.

43. The stages of respiration have no appreciable effect upon the duration of the heart-carotid intervals, nor on the velocity of the pulse-wave along the upper extremity.

Heart Disease.

44. In mitral regurgitation the arterial pulse, as respects the beginning of cardiac systole, is markedly delayed. In this condition a variety of pulse-forms ~~are~~ present, and no special form of cardiac or arterial trace is characteristic.

45. In aortic stenosis the formula is : Heart's pulsation with sustained systole ; arterial pulsation with sloping ascent and rounded or flattened top ; interval between beginning of cardiac systole and beginning of arterial pulse, normal.

46. In the condition of heavy aortic valves without stenosis, the formula is : Heart's pulsation with sustained systole ; arterial pulsation well formed ; interval between beginning of cardiac systole and beginning of arterial pulse, abnormally long.

47. In the conjoined condition of stenosis and heavy valves, the formula is : Heart's pulsation with sustained systole ; arterial pulsation both typically deformed and abnormally delayed after the beginning of cardiac systole.

The author announces his intention to publish more on the sphygmographic indications of heart disease, and that he has a paper ready on the sphymographic features of aneurism.

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